PATENT ABSTRACTS OF JAPAN

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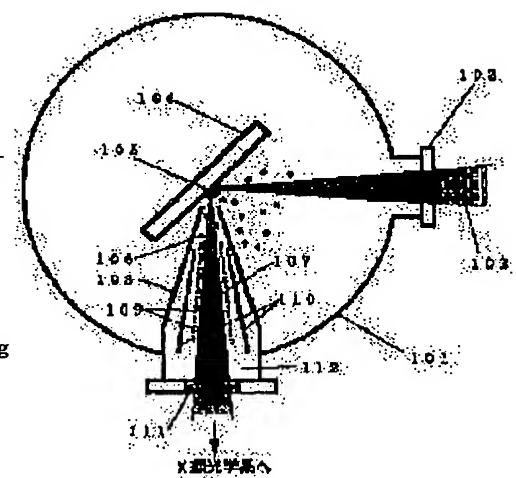
(54) X-RAY GENERATING DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To prevent attachment and deposition of sputtered particles onto a cleaned optical surface and allow a device to serve stably for a long period of time by furnishing an electrode which is positioned on the side nearer the applicable region than a sputtered particle hindering member and which ionizes or electrostatically adsorbs the sputtered particles.
SOLUTION: An X-ray transmissive film 111 is surrounded by a sputtered particle hindering member 108 in a duct shape so that the sputtered particles emitted from a target member 104 and plasma 105 to a region other than the X-ray take-out direction do not attach or deposit. In the internal space 112 of this duct, electrodes 109, 110 to ionize or electrostatically adsorb those sputtered particles 106 which have cleared hindrance of the member 108, are installed adjacent or close to a three-dimensional angular region corresponding to the area where X-rays 107 are taken out. The sputtered particles 106 having intruded into the duct space 112 will go afloat upon being decelerated by collision with gas molecules in a shield space 112. The sputtered particles having intruded into the electric field impression area are ionized by the electric field and drawn to the electrode 109 or 110 owing to the ions positive or negative.



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CLAIMS

[Claim(s)]

[Claim 1] In the X-ray generator which irradiates an excitation energy beam at the target member in the decompressed vacuum housing, is made to form the plasma, and takes out an X-ray from this plasma The scattering particle inhibition member for preventing the scattering particle which is made to adjoin or approach the solid angle field equivalent to the range which takes out said X-ray, and is emitted from said target member and/or said plasma, The X-ray generator characterized by preparing the electrode which it is [electrode] the electrode located in said solid angle field side, and ionizes and/or adsorbs [electrostatic] said scattering particle rather than this scattering particle inhibition member.

[Claim 2] In the X-ray generator which irradiates an excitation energy beam at the target member in the decompressed vacuum housing, is made to form the plasma, and takes out an X-ray from this plasma The scattering particle inhibition member for preventing the scattering particle which is made to adjoin or approach the field through which said excitation energy beam passes, and is emitted from said target member and/or said plasma, The X-ray generator characterized by preparing the electrode which it is [electrode] the electrode located in said excitation energy beam passage field side, and ionizes and/or adsorbs [electrostatic] said scattering particle rather than this scattering particle inhibition member.

[Claim 3] The X-ray generator according to claim 1 or 2 characterized by establishing the device which introduces the buffer gas for preventing a scattering particle in said decompressed vacuum housing.

[Claim 4] Said scattering particle inhibition member is an X-ray generator according to claim 1 to 3 which is the member of the shape of a duct for preventing that a scattering particle collides, adheres or deposits on the optical element or optical member arranged in said solid angle field or said excitation energy beam passage field, and is characterized by surrounding said optical element or an optical member, and being prepared.

[Claim 5] Said scattering particle inhibition member is an X-ray generator according to claim 4 characterized by being the member of the shape of a duct which has a baffle.

[Claim 6] It is the X-ray generator according to claim 4 or 5 which the gas installation device for introducing gas is established in said duct, and is characterized by said scattering particle inhibition member having a gas inlet.

[Claim 7] The X-ray generator according to claim 1 to 6 characterized by having covered a part of said electrode or scattering particle inhibition member [at least], and preparing a dismountable covering member.

[Claim 8] The X-ray generator according to claim 1 to 7 characterized by preparing the scattering particle control-section material which it is [material] the member which controls direction distribution of the burst size of said scattering particle, and reduces the scattering particle burst size to the direction which takes out said X-ray.

[Claim 9] The X-ray generator according to claim 1 to 8 characterized by preparing the cooler style which cools said scattering particle inhibition member.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention is used for X-ray plants, such as an X-ray microscope, an X-rays spectroscopic analyzer, and an X-ray aligner, and relates to a suitable X-ray generator.
[0002]
[Description of the Prior Art] If the target member placed into the vacuum housing which had laser light (an example of an excitation energy beam) decompressed is condensed and irradiated, a target member is plasma-ized quickly and what an X-ray with very high brightness is radiated for from this plasma (an X-ray is generated) (emission) is known (for example, such an X-ray generation source is called LPX:Laser-Plasma X-raysource).
[0003] With generating of an X-ray, from said plasma, the scattering particles (for example, the gasified ingredient, the ionized ingredient, an ingredient wafer, etc.) of a member ingredient are emitted from said target member, and scattering particles, such as a high-speed electron and ion, disperse in a vacuum housing from it again (these are hereafter called a scattering particle collectively). Since such a scattering particle collided with the clarification optical surface (for example, X-ray optics component), adhered, was deposited, and the function and the property were reduced or it was changed [**** / damaging these], it was a big problem.
[0004] In order to solve this problem, he was trying for a scattering particle not to arrive at a clarification optical surface by the conventional approach by installing and covering the thin film (it being hereafter called the thin film for scattering particle inhibition, or an X-ray ejection filter) which consists of roentgenoparent high matter (for example, Be) between X line source and a clarification optical surface. In addition, a clarification optical surface is made to penetrate the X-ray radiated from the mirror for reflecting the lens for condensing the aperture for introducing for example, laser light in a vacuum housing, and laser light, and the X-ray radiated from the plasma (when the condensing component is placed into the vacuum housing), and the plasma, and there is a filter for cutting the light etc. in it.
[0005] filling up the gas of the low atomic number with the high permeability to an X-ray (for example, helium gas) with the approach of others for solving said problem in a vacuum housing -- or by forming the gas stream of this gas, the gas molecule was made to collide with a scattering particle, and inhibition of a scattering particle was aimed at (refer to JP,63-292553,A).
[0006]
[Problem(s) to be Solved by the Invention] There is a trouble that the rate of radioparency of the thin film for scattering particle inhibition falls gradually by installation of the thin film for scattering particle inhibition since a scattering particle adheres and deposits on the thin film for scattering particle inhibition although adhesion of the scattering particle to a clarification optical surface and deposition can be prevented instead (the use X-ray intensity in the direction of X-ray ejection falls).
[0007] Moreover, by the approach of aiming at inhibition of a scattering particle, there is a trouble that a scattering particle cannot necessarily be prevented effectively, by [which are filled up with the gas of a low atomic number with the high transmission to an X-ray (buffer gas) in a vacuum housing] depending especially or forming the gas stream of this gas. For example, when a target member is a tantalum, within the fully exhausted vacuum housing (pressure of 10Pa or less), many scattering particles in the direction of a normal of a target member front face are distributed. And although a scattering particle will decrease about the direction where many scattering particles are emitted for dispersion by the gas molecule if the buffer gas for scattering particle inhibition is introduced in a vacuum housing, the scattered scattering particles disperse before gas installation also in the direction which had little emission of a scattering particle.
[0008] Therefore, if a buffer gas is used in order to prevent a scattering particle, distribution of the emission direction of a scattering particle will be equalized. About the direction with little emission of a scattering particle, as compared with the direction with much emission of a scattering particle, this has the small effectiveness of gas installation, or shows that it becomes an opposite effect rather. As for the ejection of an X-ray, it is common to carry out in a direction with little emission of a scattering particle, and the effectiveness of gas installation is small about the direction of ejection of an X-ray with little emission of a scattering particle, or it is a big trouble to become an opposite effect rather.
[0009] When preparing the scattering particle control-section material which it is [material] the scattering particle control-section material which controls direction distribution of the burst size of a scattering particle near the plasma especially, and reduces the burst size of the scattering particle to the direction which takes out said X-ray, the effectiveness of the gas installation about the direction of ejection of an X-ray is small, or it is a big trouble to become an opposite effect rather. This invention aims at being made in view of this trouble, and preventing adhesion of the scattering particle to a clarification optical surface, and deposition, consequently offering the X-ray generator which can use, carrying out long duration stability.
[0010]
[Means for Solving the Problem] In the X-ray generator which irradiates an excitation energy beam at the target member in the decompressed vacuum housing, is made to form the plasma, and takes out an X-ray from this plasma therefore, this invention -- the first -- "-- The scattering particle inhibition member for preventing the scattering particle which is made to adjoin or

approach the solid angle field equivalent to the range which takes out said X-ray, and is emitted from said target member and/or said plasma, The X-ray generator (claim 1) characterized by preparing the electrode which it is [electrode] the electrode located in said solid angle field side, and ionizes and/or adsorbs [electrostatic] said scattering particle rather than this scattering particle inhibition member" is offered.

[0011] In the X-ray generator which irradiates an excitation energy beam at the target member in the decompressed vacuum housing, is made to form the plasma, and takes out an X-ray from this plasma moreover, this invention -- the second -- "-- The scattering particle inhibition member for preventing the scattering particle which is made to adjoin or approach the field through which said excitation energy beam passes, and is emitted from said target member and/or said plasma, The X-ray generator (claim 2) characterized by preparing the electrode which it is [electrode] the electrode located in said excitation energy beam passage field side, and ionizes and/or adsorbs [electrostatic] said scattering particle rather than this scattering particle inhibition member" is offered.

[0012] Moreover, this invention provides the third with "the X-ray generator (claim 3) according to claim 1 or 2 characterized by establishing the device which introduces the buffer gas for preventing a scattering particle in said decompressed vacuum housing." Moreover, this invention provides the fourth with "the X-ray generator (claim 4) according to claim 1 to 3 which is the member of the shape of a duct for preventing that a scattering particle collides, adheres or deposits said scattering particle inhibition member on the optical element or optical member arranged in said solid angle field or said excitation energy beam passage field, and is characterized by surrounding said optical element or an optical member, and being prepared."

[0013] Moreover, this invention provides the fifth with "the X-ray generator (claim 5) according to claim 4 characterized by said scattering particle inhibition member being a member of the shape of a duct which has a baffle." Moreover, this invention provides the sixth with "the X-ray generator (claim 6) according to claim 4 or 5 characterized by establishing the gas installation device for introducing gas in said duct, and said scattering particle inhibition member having a gas inlet."

[0014] Moreover, this invention provides the seventh with "the X-ray generator (claim 7) according to claim 1 to 6 characterized by having covered a part of said electrode or scattering particle inhibition member [at least], and preparing a dismountable covering member." Moreover, this invention provides the eighth with "the X-ray generator (claim 8) according to claim 1 to 7 characterized by preparing the scattering particle control-section material which it is [material] the member which controls direction distribution of the burst size of said scattering particle, and reduces the scattering particle burst size to the direction which takes out said X-ray."

[0015] Moreover, this invention provides the ninth with "the X-ray generator (claim 9) according to claim 1 to 8 characterized by preparing the cooler style which cools said scattering particle inhibition member."

[0016]

[Embodiment of the Invention] "The X-ray generator of this invention (1) The scattering particle inhibition member for making the solid angle field equivalent to the range which takes out an X-ray adjoin or approach, and preventing a scattering particle, [that the electrode which it is / electrode / the electrode located in said solid angle field side, and ionizes and/or adsorbs / electrostatic / said scattering particle rather than this scattering particle inhibition member is prepared", and] Or the scattering particle inhibition member for making the field through which a "(2) excitation energy beam passes adjoin or approach, and preventing a scattering particle, The electrode which it is [electrode] the electrode located in said excitation energy beam passage field side, and ionizes and/or adsorbs [electrostatic] said scattering particle rather than this scattering particle inhibition member is prepared."

[0017] First, (1) The case where it is made a configuration [like] is explained. By preventing penetration into said solid angle field of a scattering particle by the scattering particle inhibition member which was made to adjoin or approach the solid angle field equivalent to the range which takes out an X-ray, and was prepared in it, adhesion of the scattering particle to the clarification optical surface (for example, X-ray optics components using Be film or a silicon nitride film, such as an aperture for X-ray ejection and an X-ray reflective mirror) arranged in this solid angle field and deposition can be prevented.

[0018] Furthermore, if the electrode which it is [electrode] the electrode which is made to adjoin or approach the solid angle field equivalent to the range which takes out an X-ray, and is located in said solid angle field side rather than a scattering particle inhibition member, and ionizes and/or adsorbs [electrostatic] said scattering particle is prepared When an electrode or a scattering particle inhibition member carries out electrostatic adsorption of the scattering particle which has advanced into said solid angle field, adhesion of the scattering particle to the clarification optical surface arranged in this solid angle field and deposition can be prevented further.

[0019] If the scattering particle which has advanced into said solid angle field is made to ionize by electrical-potential-difference impression to said electrode, the electrode or scattering particle inhibition member which made the ionized scattering particle reversed-polarity potential or touch-down potential will carry out electrostatic adsorption. If the device which introduces the buffer gas for preventing a scattering particle is established and a buffer gas is introduced in a vacuum housing, since it becomes easy to ionize [of the scattering particle by the collision with a buffer gas], consequently said electrostatic adsorption of a scattering particle can be performed effectively, it is desirable (claim 3).

[0020] namely, by the collision covering many times with a buffer-gas molecule, a scattering particle loses the early energy and exercises the inside of said solid angle field in the random direction at a rate comparable as a gas molecule -- it becomes like (it floats). Since the rate of this scattering particle that is floating is slow, a scattering particle is easily ionizable by arranging said electrode and impressing an electrical potential difference.

[0021] In addition, a scattering particle may be ionized by the collision with the gas molecule by which ionization of this scattering particle was ionized with the case where direct ionization of the scattering particle is carried out by electrical-potential-difference impression. As mentioned above, (1) Although the case where it was made a configuration [like] was explained (2) By preventing penetration into said field of a scattering particle by the scattering particle inhibition member which was made to adjoin or approach the field through which an excitation energy beam passes, and was similarly prepared in it about the case where it is made a configuration [like] Adhesion of the scattering particle to the clarification optical surface arranged in this field and deposition can be prevented.

[0022] Furthermore, if the electrode which it is [electrode] the electrode located in said field side rather than a scattering particle inhibition member, and ionizes and/or adsorbs [electrostatic] a scattering particle prepares, when make the field through which an excitation energy beam passes adjoin or approach, and an electrode or a scattering particle inhibition member will carry out the electrostatic adsorption of the scattering particle which has advanced into said field, adhesion of the scattering particle to the clarification optical surface arranged in this field and deposition can prevent further.
[0023] Therefore, according to the X-ray generator of this invention, it is large, consequently the effectiveness of preventing adhesion of the scattering particle to a clarification optical surface and deposition carries out long duration stability, and can use equipment. A direct current or an alternating current is sufficient as the electrical potential difference impressed to the electrode concerning this invention. Moreover, configurations of arbitration, such as the shape of a line and a mesh and tabular, are possible for the configuration of an electrode. the location which adjoins or approaches the solid angle field equivalent to the range in which the location in which an electrode is prepared takes out an X-ray -- or although it is the location which adjoins or approaches the field through which an excitation energy beam passes, depending on the case, an electrode may be prepared in the interior of said field.
[0024] It is the member of the shape of a duct for preventing that a scattering particle collides, adheres or deposits the scattering particle inhibition member concerning this invention on the optical element or optical member (clarification optical surface) arranged in said solid angle field or said excitation energy beam passage field, and it is desirable to surround said optical element or an optical member, and to be prepared (claim 4).
[0025] [if it is made this configuration, when introducing the buffer gas for preventing a scattering particle in a vacuum housing] Even if the scattering particles emitted to space other than said solid angle field or said excitation energy beam passage field are scattered about by the collision with a buffer-gas molecule and are spread in a vacuum housing Penetration into said field of a scattering particle can be exactly prevented by the scattering particle inhibition member of the shape of a duct established by surrounding said clarification optical surface.
[0026] Furthermore, it is desirable that the scattering particle inhibition member concerning this invention is a member of the shape of a duct which has a baffle (especially the inside is desirable) (claim 5). If it is made this configuration, since the surface area of a scattering particle inhibition member will increase, the effectiveness of making a scattering particle adhering or adsorbing improves. It is desirable that a gas installation device for the scattering particle inhibition member concerning this invention to introduce gas in said duct is established, and this scattering particle inhibition member has a gas inlet (claim 6).
[0027] If it is made this configuration, since the scattering particle which forms the gas stream from the interior of a duct where said optical element or the optical member (clarification optical surface) has been arranged to into a vacuum housing, and is floating in a duct can be eliminated out of a duct, the effectiveness of preventing adhesion of the scattering particle to a clarification optical surface and deposition increases further. as this gas — Kr, helium, O2, and N2 etc. -- it can be used.
[0028] In this invention, it is desirable to cover a part of said electrode or scattering particle inhibition member [at least], and to prepare a dismountable covering member (claim 7). In an X-ray generator, if X-ray generating operation is continued for a long time, a scattering particle will come to deposit on said scattering particle inhibition member and electrode gradually. Then, the dismountable covering member concerning claim 7 is prepared, and a scattering particle is made to deposit on this member.
[0029] And after carrying out fixed period use, the inside of said solid angle field or said excitation energy beam passage field can be again returned to a pure condition by removing this covering member and exchanging for a new covering member. In addition, if an insulator is used for a covering member, since the capacity to become possible to electrify this whole member and to collect scattering particles will increase, it is convenient.
[0030] In this invention, it is the member which controls direction distribution of the burst size of said scattering particle, and it is desirable to prepare the scattering particle control-section material which reduces the scattering particle burst size to the direction which takes out said X-ray (claim 8). If scattering particle control-section material is prepared, since the scattering particle burst size in the direction of ejection of an X-ray will decrease, it is desirable. As an ingredient used for the scattering particle control-section material concerning this invention, high-melting [, such as a tantalum, a tungsten, a diamond, and a ceramic,] or the ingredient of a high degree of hardness is desirable, for example.
[0031] Since scattering particle control-section material is arranged in the location which approached the plasma very much, this is for reducing emission of this member ingredient by the collision to this member front face of ion or an electron that comes flying from the plasma. That is, since inconvenient adhesion and deposition will arise like a scattering particle if there is emission of this member ingredient, this is reduced. In this invention, if the cooler style which cools a scattering particle inhibition member is prepared, since this member will become easy to adsorb a scattering particle and the inhibition effectiveness will increase, it is desirable (claim 9).
[0032] Or it is also desirable to process the front face of a scattering particle inhibition member or said covering member (for example, delustering processing) so that it may be easy to adsorb a scattering particle. Since the effectiveness (the scattering particle inhibition effectiveness) that the one where the surface area is larger adheres, and makes a scattering particle deposit is large, as for the electrode or member on which adhere and a scattering particle is made to deposit, it is desirable to enlarge surface area of an electrode or a member.
[0033] X line source concerning this invention may be an X-ray laser which condenses to a line the laser light other than X line source (for example, laser plasma X line source) which condenses an excitation energy beam (for example, laser light) to punctiform, generates the plasma, and uses the induced emission of the ion in the plasma. Hereafter, although an example explains this invention to a detail further, this invention is not limited to these examples.
[0034]
[Example 1] Drawing 1 is the outline partial block diagram of the X-ray generator of this example. The plasma 105 is generated by carrying out convergent radiotherapy of the laser light (an example of an excitation energy beam) 103 which condensed with the condenser lens on the target member 104 which was made to penetrate an aperture 102 and has been arranged in a vacuum housing 101.
[0035] After taking out a part of X-ray 107 generated from this plasma 105 and making the light cut radioparency film (for

example, an example of Be film and an X-ray optics component) 111 penetrate, it leads to other X-ray optics components (for example, X-ray multilayers mirror etc.). The inside of a vacuum housing 101 is exhausted by evacuation equipment (un-illustrating) while the buffer gas for scattering particle inhibition (for example, Kr gas) is introduced from a gas inlet (un-illustrating). Here, the buffer gas in a vacuum housing 101 has a fully high rate of radioparency, and it is controlled by the pressure which can fully slow down the rate of a scattering particle.
[0036] For example, when Kr gas is introduced and a pressure is maintained to 0.1 torr, a scattering particle comes (it floats) to exercise in the random direction at a rate comparable as Kr gas molecule by Kr gas molecule and about ten collisions [several -]. At this time, the permeability of an X-ray with a wavelength of about 13.5nm reaches to about 80% in a location with a distance of 10cm. The radioparency film 111 is enclosed by the duct-like scattering particle inhibition member 108 so that the scattering particle emitted to fields other than the direction of X-ray ejection may not adhere and deposit from said target member 104 and/or said plasma 105.
[0037] Moreover, the space 112 in a duct is made to adjoin or approach the solid angle field equivalent to the range which takes out X-ray 107, and the electrodes 109 and 110 which ionize and/or adsorb [electrostatic] the scattering particle 106 which was not prevented by said scattering particle inhibition member 108 are arranged in it. The electrode 110 is carrying out the configuration which encloses an electrode 109 and ejection X-ray 107 (solid angle field). The electrical potential difference of plus is impressed to the electrode 110 of minus at the electrode 109 (a power source, wiring, etc. are un-illustrating).
[0038] The scattering particle 106 which entered the space 112 in a duct (electric shielding space) is slowed down by the collision with the gas molecule in the electric shielding space 112, and comes to float the inside of electric shielding space. The scattering particle which entered the electric-field impression field is ionized by the collision with the ionized gas molecule in which direct ionization was carried out by electric field. The scattering particle ionized by minus can be drawn near to the plus electrode 110, on this electrode, electrostatic adsorption is carried out, and adheres and is deposited. Moreover, the scattering particle ionized by plus can be drawn near to the minus electrode 109, on this electrode, electrostatic adsorption is carried out, and adheres and is deposited. Moreover, some scattering particles are adhered and deposited on the inhibition member 108.
[0039] Thus, since the scattering particles which are floating in the electric shielding space 112 are collected on electrodes 109 and 110 and a member 108, the scattering particle weight which is floating in the electric shielding space 112 decreases sharply. Therefore, since adhesion of a up to [the radioparency film 111] and alimentation are reduced remarkably and decline in the rate of radioparency is suppressed, an X-ray generator can be used over a long time.
[0040] Although the pole of plus and two minus has been arranged in the electric shielding space 112 in the aforementioned example, only one of poles are. For example, if an electrode 109 is impressed to minus, an electrode 110 is grounded and it is made a vacuum housing 101 the inhibition member 108, etc. and same electric potential, on an electrode 110 and the inside of the scattering particle inhibition member 108, electrostatic adsorption is carried out, respectively, and the scattering particle by which the scattering particle ionized by plus was ionized by minus on the electrode 109 will adhere, and will be deposited.
[0041] deciding the polarity of an electrical-potential-difference impression electrode, when it turns out beforehand to which of a forward anion a scattering particle ionizes -- a scattering particle -- an electrical-potential-difference impression electrode top — or it can be made to deposit on either on an earth electrode and an inhibition member
[0042]
[Example 2] Drawing 2 is the outline partial block diagram of the X-ray generator of this example. In an example 1, if a scattering particle collection side is used as an electrode 110 and the inhibition member 108, a part of ionized scattering particle will be slightly adhered and deposited also on the radioparency film 111 electrically connected with the inhibition member 108 or the vacuum housing 101.
[0043] In order to prevent this, in this example, the radioparency film 210 (an example of an X-ray optics component) is attached in the vacuum housing 201 through the insulator 211. That is, the radioparency film 210 is electrically isolated from a vacuum housing 201, and this radioparency film 210 is connected to the power source (un-illustrating) so that it may become an electrode 209 and same electric potential. In addition, the number of electrodes is one and other configurations are the same as that of an example 1.
[0044] For example, although the ionized scattering particle will carry out adhesion deposition on the inhibition member 208 grounded supposing it impresses an electrode 209 to minus and ionizes a scattering particle to minus, it does not adhere on the radioparency film 210 which is an electrode and same electric potential. The ionized scattering particle can be made to adhere only to inhibition member 208 inside by making it this appearance.
[0045] The electrical-potential-difference value impressed to the radioparency film 210 may not necessarily be the same as the electrical-potential-difference value currently impressed to the electrode 209, and should just be the polarity same at least as an electrode. Since according to the X-ray generator of this example adhesion of a up to [the radioparency film 210] and alimentation are reduced remarkably and decline in the rate of radioparency is suppressed, an X-ray generator can be used over a long time.
[0046]
[Example 3] Drawing 3 is the outline partial block diagram of the X-ray generator of this example. In an example 1, if a scattering particle collection side is used as an electrode 110 and the inhibition member 108, a part of ionized scattering particle will be slightly adhered and deposited also on the radioparency film 111 electrically connected with the inhibition member 108 or the vacuum housing 101.
[0047] In order to prevent this, he arranges the mesh electrode 311 held at the inhibition member 308 and same electric potential in front of the radioparency film 310 (one example of an X-ray optics component) (plasma side), and is trying for the scattering particle ionized at the mesh electrode 311 side to deposit in this example. In addition, the number of electrodes is one and other configurations are the same as that of an example 1.
[0048] Since according to the X-ray generator of this example adhesion of a up to [the radioparency film 310] and alimentation are reduced remarkably and decline in the rate of radioparency is suppressed, an X-ray generator can be used over a long time.
[0049]

[Example 4] Drawing 4 is the outline partial block diagram of the X-ray generator of this example. In this example, the inlet 411 for introducing gas is established in 412 in electric shielding space. In addition, the number of electrodes is one and other configurations are the same as that of an example 1. By introducing gas from this inlet 411, the gas stream from the electric shielding space 412 to the vacuum housing 401 interior is formed, and the scattering particle in the electric shielding space 412 is discharged into a vacuum housing 401.
[0050] Therefore, the scattering particle weight in the electric shielding space 412 decreases sharply, and adhesion of a up to [the radioparency film 410] and alimentation are reduced remarkably. And since the rate fall of radioparency of the radioparency film 410 is suppressed, an X-ray generator can be used over a long time.
[0051]
[Example 5] Drawing 5 is the outline partial block diagram of the X-ray generator of this example. An electrode 509 is arranged in the electric shielding space 512, and the dismountable sheets (an example of a covering member, for example, paper, Teflon sheet, etc.) 511 have covered the inside of the scattering particle inhibition member 508 in this example. Other configurations are the same as that of an example 1.
[0052] Now, an electrode 509 is impressed to minus, the inhibition member 508 and a vacuum housing 501 presuppose that it is grounded, and a scattering particle presupposes that it is ionized by minus. If it does so, the ionized scattering particle can be drawn near to the inhibition member 508 side, and will be adhered and deposited on a sheet 511. Although a scattering particle will deposit so much on a sheet 511 if it continues operating an X-ray generator over a long period of time, the scattering particle easily collected out of the electric shielding space 512 can be removed only by exchanging a sheet 511, and the inside of the electric shielding space 512 can be returned to the original pure condition.
[0053] Although the sheet was used in this example as an exchangeable member which collects scattering particles, this is good with the configuration of arbitration, and an ingredient (an insulator is desirable). Since according to the X-ray generator of this example adhesion of a up to [the radioparency film 510] and alimentation are reduced remarkably and decline in the rate of radioparency is suppressed, an X-ray generator can be used over a long time.
[0054]
[Example 6] Drawing 6 is the outline partial block diagram of the X-ray generator of this example. Although it is arranged in the examples 1-5 so that a scattering particle inhibition member may surround an X-ray optics component, the need does not not necessarily exist. In this example, it is arranged in the vacuum housing (601 and 611) with respectively different a plasma 605X line source and the multilayers X-ray reflective mirror 610 (an example of an X-ray optics component), and the scattering particle inhibition member 608 and the electrode 609 are formed in the middle.
[0055] Since the scattering particle ionized also in this case by the same effectiveness as the above-mentioned is adhered and deposited on an intermediate vacuum piping inside on an electrode 609 and the inhibition member 608, the scattering particle weight adhered and deposited on the multilayers X-ray reflective mirror 610 can be reduced. Since according to the X-ray generator of this example adhesion of a up to [the radioparency film 610] and alimentation are reduced remarkably and decline in the rate of radioparency is suppressed, an X-ray generator can be used over a long time.
[0056] Although the above examples 1-6 have described reducing adhesion of the scattering particle to an X-ray optics component, and alimentation, it is possible similarly to reduce adhesion of the scattering particle to laser photoconductive close optical elements (a laser light installation aperture, condensing optical element, etc.) and alimentation. That is, adhesion of the scattering particle to the clarification optical surface arranged in this field and deposition can be prevented by preventing penetration into said field of a scattering particle by the scattering particle inhibition member which was made to adjoin or approach the field through which the laser light which is an excitation energy beam passes, and was prepared in it.
[0057] Furthermore, if the electrode which it is [electrode] the electrode which is made to adjoin or approach the field through which the laser light which is an excitation energy beam passes, and is located in said field side rather than a scattering particle inhibition member, and ionizes and/or adsorbs [electrostatic] a scattering particle is prepared When an electrode or a scattering particle inhibition member carries out electrostatic adsorption of the scattering particle which has advanced into said field, adhesion of the scattering particle to the clarification optical surface arranged in this field and deposition can be prevented further.
[0058]
[Effect of the Invention] According to the X-ray generator of this invention, as explained above, it is remarkable, consequently the effectiveness of preventing adhesion of the scattering particle to a clarification optical surface and deposition carries out long duration stability, and can use equipment.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] They are ** and the outline partial block diagram of the X-ray generator of an example 1.
[Drawing 2] They are ** and the outline partial block diagram of the X-ray generator of an example 2.
[Drawing 3] They are ** and the outline partial block diagram of the X-ray generator of an example 3.
[Drawing 4] They are ** and the outline partial block diagram of the X-ray generator of an example 4.
[Drawing 5] They are ** and the outline partial block diagram of the X-ray generator of an example 5.
[Drawing 6] They are ** and the outline partial block diagram of the X-ray generator of an example 6.
[Description of Notations]
101, 201, 301,401,501,601 -- Vacuum housing
102, 202, 302,402,502,602 -- Laser light installation aperture
103, 203, 303,403,503,603 -- Laser light (an example of an excitation energy beam)
104, 204, 304,404,504,604 -- Target member
105, 205, 305,405,505,605 -- Plasma
106, 206, 306,406,506,606 -- Scattering particle
107, 207, 307,407,507,607 -- X-ray to be used
108, 208, 308,408,508,608 -- Scattering particle inhibition member
109, 209, 309,409,509,609 -- Electrode
110 -- Electrode
210,310,410,510 -- Light cut radioparency film (a clarification optical surface and an example of an optical element)
610 -- Multilayers X-ray reflective mirror (a clarification optical surface and an example of an optical element)
111 -- Light cut radioparency film (a clarification optical surface and an example of an optical element)
211 -- Insulator
311 -- Mesh electrode
411 -- Gas inlet
511 -- Sheet (an example of a dismountable covering member)
611 -- Vacuum housing
112, 212, 312,412,512,612 -- Electric shielding space
with -- Top

[Translation done.]

* NOTICES *

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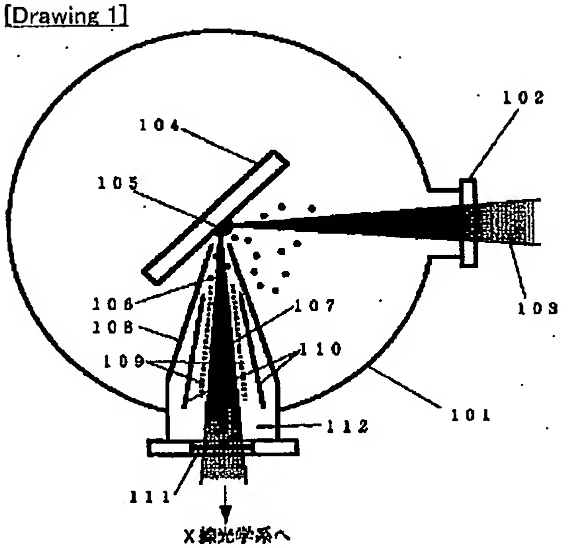
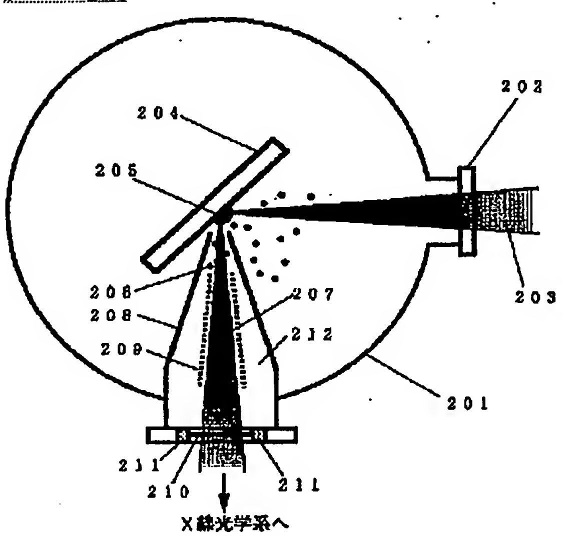
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

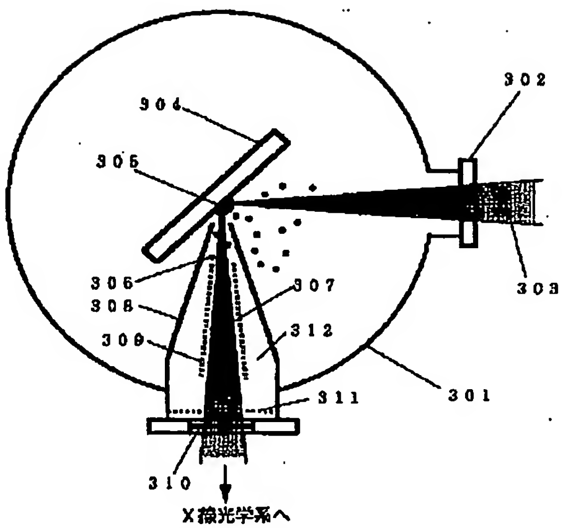
[Drawing 1]



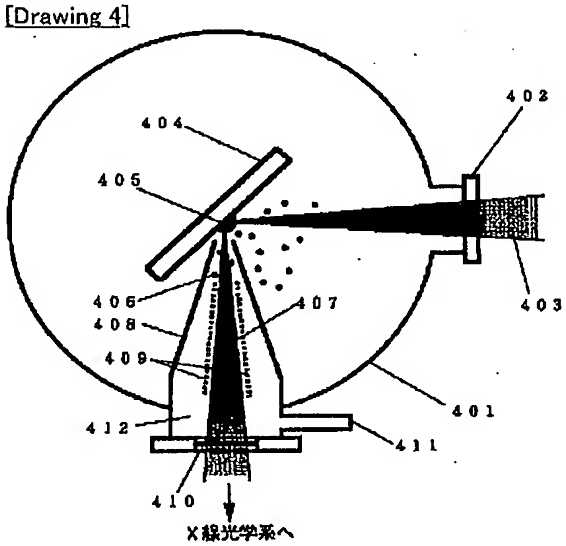
[Drawing 2]



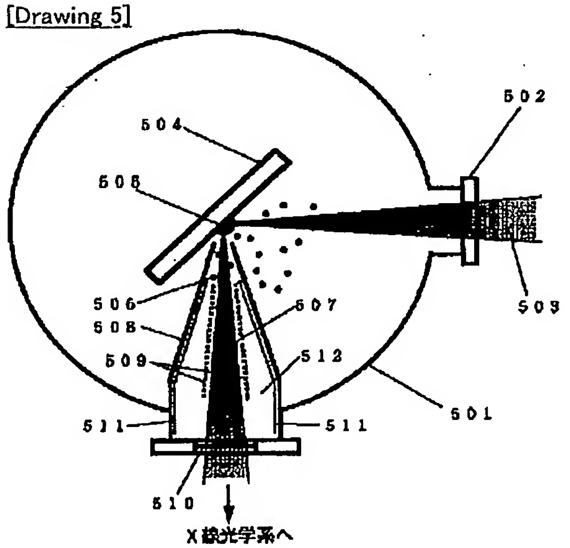
[Drawing 3]



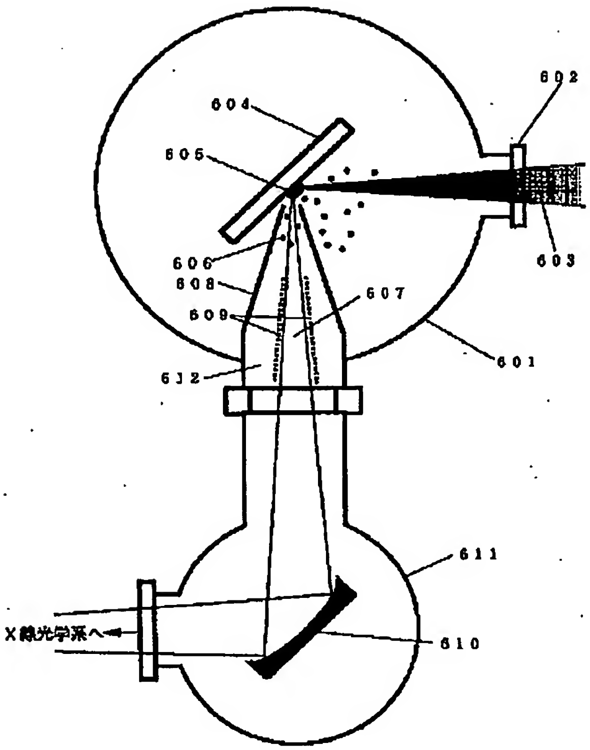
[Drawing 4]



[Drawing 5]



[Drawing 6]



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CORRECTION OR AMENDMENT

[Kind of official gazette] Printing of amendment by the convention of 2 of Article 17 of Patent Law
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[Publication date] June 20, Heisei 15 (2003. 6.20)

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[The 7th edition of International Patent Classification]

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H05G 1/00 K
1/02 J

[Procedure revision]
[Filing Date] March 13, Heisei 15 (2003. 3.13)
[Procedure amendment 1]
[Document to be Amended] Specification
[Item(s) to be Amended] The name of Invention
[Method of Amendment] Modification
[Proposed Amendment]
[Title of the Invention] An X-ray generator and an X-ray aligner
[Procedure amendment 2]
[Document to be Amended] Specification
[Item(s) to be Amended] Claim
[Method of Amendment] Modification
[Proposed Amendment]
[Claim(s)]
[Claim 1] In the X-ray generator using the X-ray radiated from the plasma,
The scattering particle inhibition member for preventing the scattering particle which was made to adjoin or approach the solid angle field equivalent to the range which takes out an X-ray from the plasma, and has been arranged,
It has the electrode which ionizes and/or adsorbs [electrostatic] said scattering particle,
The X-ray generator characterized by arranging said electrode rather than said scattering particle inhibition member said solid angle field side or in said solid angle field.
[Claim 2] In the X-ray generator using the X-ray radiated from the plasma,
The scattering particle inhibition member for preventing the scattering particle which was made to adjoin or approach the field through which the excitation energy beam irradiated by the target member for forming said plasma passes, and has been arranged,
X filament student equipment characterized by preparing the electrode which it is arranged [electrode] at said excitation energy beam passage side, and ionizes and/or adsorbs [electrostatic] said scattering particle rather than said scattering particle inhibition member.
[Claim 3] The X-ray generator according to claim 1 to 2 characterized by carrying out the seal of approval of direct current voltage or the alternating voltage to said electrode.
[Claim 4] The X-ray generator according to claim 1 to 3 characterized by establishing the device which introduces the buffer gas for preventing a scattering particle in said decompressed vacuum housing.
[Claim 5] Said scattering particle inhibition member is an X-ray generator according to claim 1 to 4 which is the member of the shape of a duct for preventing that a scattering particle collides, adheres or **** to the optical element or optical member arranged to said solid angle field or said excitation energy beam passage field, and is characterized by surrounding said optical element or an optical member, and being prepared.
[Claim 6] Said scattering rough child inhibition member is an X-ray generator according to claim 5 characterized by being the

member of the shape of a duct which has a baffle.
[Claim 7] The X-ray generator according to claim 5 or 6 characterized by establishing the gas installation device for introducing gas in said duct.
[Claim 8] The X-ray generator according to claim 7 characterized by the gas introduced in said duct being gas containing at least one of a krypton (Kr), helium (helium), oxygen (O2), and nitrogen (N2).
[Claim 9] The X-ray generator according to claim 1 to 8 characterized by having covered a part of said electrode or scattering particle inhibition member [at least], and preparing a dismountable covering member.
[Claim 10] The X-ray generator according to claim 9 characterized by said covering members being insulators, such as paper and Teflon.
[Claim 11] The X-ray generator according to claim 1 to 10 characterized by impressing the electrical potential difference of said electrode and like-pole nature to an optical element.
[Claim 12] The X-ray generator according to claim 1 to 11 characterized by arranging the X-ray optics component in the vacuum housing other than the vacuum housing by which said plasma is generated, and arranging the scattering particle inhibition member and the electrode between said plasma and said X-ray optics components.
[Claim 13] The X-ray generator according to claim 1 to 12 characterized by the configurations of said electrode being the shape of a line and a mesh, and tabular.
[Claim 14] The X-ray generator according to claim 1 to 12 characterized by having arranged further the electrode held between an optical element and said plasma at said scattering particle inhibition member and same electric potential.
[Claim 15] The X-ray generator according to claim 1 to 14 characterized by preparing the scattering particle control-section material which it is [material] the member which controls direction distribution of the burst size of said scattering particle, and reduces the scattering particle burst size to the direction which takes out said X-ray.
[Claim 16] The X-ray generator according to claim 15 with which said scattering particle control-section material is characterized by being made of the ingredient containing at least one of a tantalum (Ta), a tungsten (W), a diamond, and ceramics.
[Claim 17] The X-ray generator according to claim 1 to 16 characterized by preparing the cooler style which cools said scattering particle inhibition member.
[Claim 18] The X-ray aligner which equipped any 1 term of claims 1-17 with the X-ray generator of a publication.

[Translation done.]

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1/02			1/02	Ｊ

審査請求　未請求　請求項の数９　ＯＬ　（全９頁）

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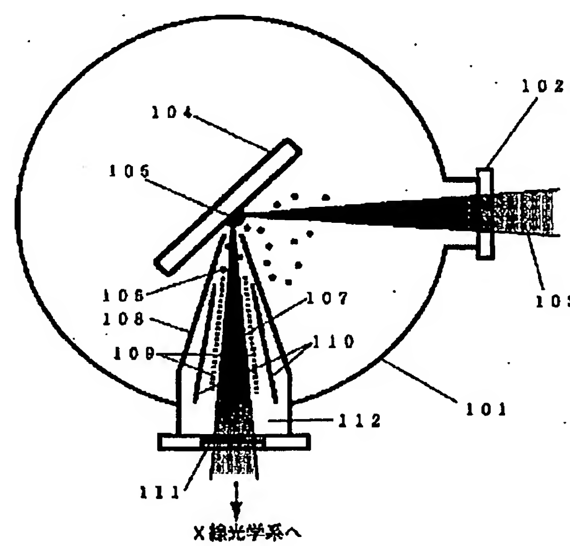
(54)【発明の名称】　Ｘ線発生装置

(57)【要約】
【課題】　清浄光学面への飛散粒子の付着、堆積を防止して、その結果、長時間安定して使用できるＸ線発生装置を提供すること。
【解決手段】　減圧された真空容器１０１内の標的部材１０４に励起エネルギービーム１０３を照射してプラズマ１０５を形成させ、該プラズマ１０５からＸ線１０７を取り出すＸ線発生装置において、前記Ｘ線１０７を取り出す範囲に相当する立体角領域に隣接または近接させて、前記標的部材１０４及び／または前記プラズマ１０５から放出される飛散粒子を阻止するための飛散粒子阻止部材１０８と、該飛散粒子阻止部材１０８よりも前記立体角領域側に位置する電極であり前記飛散粒子をイオン化及び／または静電吸着させる電極１０９、１１０とを設けたことを特徴とするＸ線発生装置。



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【特許請求の範囲】

【請求項１】　減圧された真空容器内の標的部材に励起エネルギービームを照射してプラズマを形成させ、該プラズマからＸ線を取り出すＸ線発生装置において、
前記Ｘ線を取り出す範囲に相当する立体角領域に隣接または近接させて、前記標的部材及び／または前記プラズマから放出される飛散粒子を阻止するための飛散粒子阻止部材と、該飛散粒子阻止部材よりも前記立体角領域側に位置する電極であり前記飛散粒子をイオン化及び／または静電吸着させる電極とを設けたことを特徴とするＸ線発生装置。

【請求項２】　減圧された真空容器内の標的部材に励起エネルギービームを照射してプラズマを形成させ、該プラズマからＸ線を取り出すＸ線発生装置において、
前記励起エネルギービームが通過する領域に隣接または近接させて、前記標的部材及び／または前記プラズマから放出される飛散粒子を阻止するための飛散粒子阻止部材と、該飛散粒子阻止部材よりも前記励起エネルギービーム通過領域側に位置する電極であり前記飛散粒子をイオン化及び／または静電吸着させる電極とを設けたことを特徴とするＸ線発生装置。

【請求項３】　前記減圧された真空容器内に飛散粒子を阻止するためのバッファガスを導入する機構を設けたことを特徴とする請求項１または２記載のＸ線発生装置。

【請求項４】　前記飛散粒子阻止部材は、前記立体角領域または前記励起エネルギービーム通過領域内に配置された光学素子または光学部材に飛散粒子が衝突、付着または堆積するのを防止するためのダクト状の部材であり、前記光学素子または光学部材を取り囲んで設けられていることを特徴とする請求項１～３記載のＸ線発生装置。

【請求項５】　前記飛散粒子阻止部材は、バッフルを有するダクト状の部材であることを特徴とする請求項４記載のＸ線発生装置。

【請求項６】　前記ダクト内にガスを導入するためのガス導入機構が設けられ、前記飛散粒子阻止部材はガス導入口を有することを特徴とする請求項４または５記載のＸ線発生装置。

【請求項７】　前記電極または飛散粒子阻止部材の少なくとも一部を被覆し、取り外し可能な被覆部材を設けたことを特徴とする請求項１～６記載のＸ線発生装置。

【請求項８】　前記飛散粒子の放出量の方向分布を制御する部材であり、前記Ｘ線を取り出す方向への飛散粒子放出量を低減させる飛散粒子制御部材を設けたことを特徴とする請求項１～７記載のＸ線発生装置。

【請求項９】　前記飛散粒子阻止部材を冷却する冷却機構を設けたことを特徴とする請求項１～８記載のＸ線発生装置。

【発明の詳細な説明】

【０００１】

2

【発明の属する技術分野】本発明は、Ｘ線顕微鏡、Ｘ線分析装置、Ｘ線露光装置などのＸ線装置に用いて好適なＸ線発生装置に関するものである。

【０００２】

【従来の技術】レーザー光（励起エネルギービームの一例）を減圧された真空容器内に置かれた標的部材に集光して照射すると、標的部材は急速にプラズマ化し、このプラズマから非常に輝度の高いＸ線が輻射（放出）される（Ｘ線を発生する）ことが知られている（例えば、このようなＸ線発生源はＬＰＸ：Laser-Plasma X-raysource と呼ばれる）。

【０００３】Ｘ線の発生と共に、前記プラズマからは高速の電子やイオン等の飛散粒子が、また前記標的部材からは部材材料の飛散粒子（例えば、ガス化した材料、イオン化した材料、材料小片など）が放出されて真空容器内に飛散する（以下、これらをまとめて飛散粒子と呼ぶ）。このような飛散粒子は、清浄光学面（例えば、Ｘ線光学素子）に衝突して、これらを破損したり、或いは付着、堆積して機能や特性を低下させたり変化させるので、大きな問題であった。

【０００４】この問題を解決するために従来の方法では、Ｘ線源と清浄光学面との間に、Ｘ線透過性の高い物質（例えば、Ｂｅ）からなる薄膜（以下、飛散粒子阻止用薄膜またはＸ線取り出しフィルターと呼ぶ）を設置して遮蔽することにより、飛散粒子が清浄光学面に到達しないようにしていた。なお、清浄光学面には、例えば、レーザー光を真空容器内に導入するための窓、レーザー光を集光するためのレンズ（集光素子が真空容器内に置かれている場合）、プラズマから輻射されたＸ線を反射するためのミラー、プラズマから輻射されるＸ線を透過させ、可視光をカットするためのフィルターなどがある。

【０００５】前記問題を解決するためのその他の方法では、真空容器内にＸ線に対する透過率の高い低原子番号のガス（例えば、Ｈｅガス）を充填することにより、或いは該ガスのガス流を形成することにより、飛散粒子にガス分子を衝突させて飛散粒子の阻止を図っていた（特開昭63-292553 参照）。

【０００６】

【発明が解決しようとする課題】飛散粒子阻止用薄膜の設置により、清浄光学面への飛散粒子の付着、堆積は防げるが、そのかわり、飛散粒子阻止用薄膜上に飛散粒子が付着、堆積するので、飛散粒子阻止用薄膜のＸ線透過率が次第に低下する（Ｘ線取り出し方向における使用Ｘ線強度が低下する）という問題点がある。

【０００７】また、真空容器内にＸ線に対する透過率の高い低原子番号のガス（バッファガス）を充填することにより、或いは該ガスのガス流を形成することにより、飛散粒子の阻止を図る方法では、必ずしも飛散粒子を有効に阻止できるわけではないという問題点がある。例え

ば、標的部材がタンタルである場合に、十分に排気された（圧力１０Ｐａ以下）真空容器内では、飛散粒子は標的部材表面の法線方向に多く分布する。そして、真空容器内に飛散粒子阻止用のバッファガスを導入すると、飛散粒子が多く放出される方向については、ガス分子による散乱のために飛散粒子は減少するが、散乱した飛散粒子はガス導入前には飛散粒子の放出が少なかった方向にも飛散する。

【０００８】そのため、飛散粒子を阻止するためにバッファガスを使用すると、飛散粒子の放出方向の分布が均一化される。このことは、飛散粒子の放出が少ない方向については、飛散粒子の放出が多い方向と比較してガス導入の効果が小さいか、むしろ逆効果となることを示している。Ｘ線の取り出しは、飛散粒子の放出が少ない方向において行うのが一般的であり、飛散粒子の放出が少ないＸ線の取り出し方向について、ガス導入の効果が小さいか、むしろ逆効果となることは大きな問題点である。

【０００９】特に、プラズマ近傍に飛散粒子の放出量の方向分布を制御する飛散粒子制御部材であり、前記Ｘ線を取り出す方向への飛散粒子の放出量を低減させる飛散粒子制御部材を設ける場合に、Ｘ線の取り出し方向について、ガス導入の効果が小さいか、むしろ逆効果となることは大きな問題点である。本発明は、かかる問題点に鑑みてなされたものであり、清浄光学面への飛散粒子の付着、堆積を防止して、その結果、長時間安定して使用できるＸ線発生装置を提供することを目的とする。

【００１０】

【課題を解決する為の手段】そのため、本発明は第一に「減圧された真空容器内の標的部材に励起エネルギービームを照射してプラズマを形成させ、該プラズマからＸ線を取り出すＸ線発生装置において、前記Ｘ線を取り出す範囲に相当する立体角領域に隣接または近接させて、前記標的部材及び／または前記プラズマから放出される飛散粒子を阻止するための飛散粒子阻止部材と、該飛散粒子阻止部材よりも前記立体角領域側に位置する電極であり前記飛散粒子をイオン化及び／または静電吸着させる電極とを設けたことを特徴とするＸ線発生装置（請求項１）」を提供する。

【００１１】また、本発明は第二に「減圧された真空容器内の標的部材に励起エネルギービームを照射してプラズマを形成させ、該プラズマからＸ線を取り出すＸ線発生装置において、前記励起エネルギービームが通過する領域に隣接または近接させて、前記標的部材及び／または前記プラズマから放出される飛散粒子を阻止するための飛散粒子阻止部材と、該飛散粒子阻止部材よりも前記励起エネルギービーム通過領域側に位置する電極であり前記飛散粒子をイオン化及び／または静電吸着させる電極とを設けたことを特徴とするＸ線発生装置（請求項２）」を提供する。

【００１２】また、本発明は第三に「前記減圧された真空容器内に飛散粒子を阻止するためのバッファガスを導入する機構を設けたことを特徴とする請求項１または２記載のＸ線発生装置（請求項３）」を提供する。また、本発明は第四に「前記飛散粒子阻止部材は、前記立体角領域または前記励起エネルギービーム通過領域内に配置された光学素子または光学部材に飛散粒子が衝突、付着または堆積するのを防止するためのダクト状の部材であり、前記光学素子または光学部材を取り囲んで設けられていることを特徴とする請求項１～３記載のＸ線発生装置（請求項４）」を提供する。

【００１３】また、本発明は第五に「前記飛散粒子阻止部材は、バッフルを有するダクト状の部材であることを特徴とする請求項４記載のＸ線発生装置（請求項５）」を提供する。また、本発明は第六に「前記ダクト内にガスを導入するためのガス導入機構が設けられ、前記飛散粒子阻止部材はガス導入口を有することを特徴とする請求項４または５記載のＸ線発生装置（請求項６）」を提供する。

【００１４】また、本発明は第七に「前記電極または飛散粒子阻止部材の少なくとも一部を被覆し、取り外し可能な被覆部材を設けたことを特徴とする請求項１～６記載のＸ線発生装置（請求項７）」を提供する。また、本発明は第八に「前記飛散粒子の放出量の方向分布を制御する部材であり、前記Ｘ線を取り出す方向への飛散粒子放出量を低減させる飛散粒子制御部材を設けたことを特徴とする請求項１～７記載のＸ線発生装置（請求項８）」を提供する。

【００１５】また、本発明は第九に「前記飛散粒子阻止部材を冷却する冷却機構を設けたことを特徴とする請求項１～８記載のＸ線発生装置（請求項９）」を提供する。

【００１６】

【発明の実施の形態】本発明のＸ線発生装置では、「(1) Ｘ線を取り出す範囲に相当する立体角領域に隣接または近接させて、飛散粒子を阻止するための飛散粒子阻止部材と、該飛散粒子阻止部材よりも前記立体角領域側に位置する電極であり前記飛散粒子をイオン化及び／または静電吸着させる電極とを設けている」か、或いは「(2) 励起エネルギービームが通過する領域に隣接または近接させて、飛散粒子を阻止するための飛散粒子阻止部材と、該飛散粒子阻止部材よりも前記励起エネルギービーム通過領域側に位置する電極であり前記飛散粒子をイオン化及び／または静電吸着させる電極とを設けている」。

【００１７】先ず、(1) のような構成にした場合について説明する。Ｘ線を取り出す範囲に相当する立体角領域に隣接または近接させて設けられた飛散粒子阻止部材により飛散粒子の前記立体角領域内への進入を阻止することで、該立体角領域内に配置された清浄光学面（例え

ば、Ｂｅ膜や窒化シリコン膜を用いたＸ線取り出し用窓、Ｘ線反射ミラー等のＸ線光学素子）への飛散粒子の付着、堆積を防止することができる。

【００１８】さらに、Ｘ線を取り出す範囲に相当する立体角領域に隣接または近接させて、飛散粒子阻止部材よりも前記立体角領域側に位置する電極であり前記飛散粒子をイオン化及び／または静電吸着させる電極を設けると、前記立体角領域内に進入してきた飛散粒子を電極または飛散粒子阻止部材が静電吸着することにより、該立体角領域内に配置された清浄光学面への飛散粒子の付着、堆積をさらに防止することができる。

【００１９】前記立体角領域内に進入してきた飛散粒子を前記電極への電圧印加によりイオン化させると、イオン化した飛散粒子を逆極性電位、または接地電位とした電極もしくは飛散粒子阻止部材が静電吸着する。真空容器内に飛散粒子を阻止するためのバッファガスを導入する機構を設けてバッファガスを導入すると、バッファガスとの衝突による飛散粒子のイオン化が容易となり、その結果、飛散粒子の前記静電吸着を効果的に行うことができるので好ましい（請求項３）。

【００２０】即ち、飛散粒子は、バッファガス分子との多数回にわたる衝突により、その初期のエネルギーを失い、ガス分子と同程度の速度で前記立体角領域内をランダムな方向に運動する（浮遊する）ようになる。この浮遊している飛散粒子の速度は遅いので、前記電極を配置して電圧を印加することにより飛散粒子を容易にイオン化することができる。

【００２１】なお、この飛散粒子のイオン化は、電圧印加により飛散粒子が直接イオン化される場合と、イオン化されたガス分子との衝突により飛散粒子がイオン化される場合がある。以上、(1) のような構成にした場合について説明したが、(2) のような構成にした場合についても同様に、励起エネルギービームが通過する領域に隣接または近接させて設けられた飛散粒子阻止部材により飛散粒子の前記領域内への進入を阻止することで、該領域内に配置された清浄光学面への飛散粒子の付着、堆積を防止することができる。

【００２２】さらに、励起エネルギービームが通過する領域に隣接または近接させて、飛散粒子阻止部材よりも前記領域側に位置する電極であり飛散粒子をイオン化及び／または静電吸着させる電極を設けると、前記領域内に進入してきた飛散粒子を電極または飛散粒子阻止部材が静電吸着することにより、該領域内に配置された清浄光学面への飛散粒子の付着、堆積をさらに防止することができる。

【００２３】従って、本発明のＸ線発生装置によれば、清浄光学面への飛散粒子の付着、堆積を防止する効果が大きく、その結果、長時間安定して装置を使用できる。本発明にかかる電極に印加する電圧は直流でも交流でも良い。また、電極の形状は、線状、メッシュ状、板状など、任意の形状が可能である。電極を設ける位置は、Ｘ線を取り出す範囲に相当する立体角領域に隣接または近接する位置か、或いは励起エネルギービームが通過する領域に隣接または近接する位置であるが、場合によっては前記領域内部に電極を設けてもよい。

【００２４】本発明にかかる飛散粒子阻止部材は、前記立体角領域または前記励起エネルギービーム通過領域内に配置された光学素子または光学部材（清浄光学面）に飛散粒子が衝突、付着または堆積するのを防止するためのダクト状の部材であり、前記光学素子または光学部材を取り囲んで設けられていることが好ましい（請求項４）。

【００２５】かかる構成にすると、真空容器内に飛散粒子を阻止するためのバッファガスを導入する場合においても、前記立体角領域または前記励起エネルギービーム通過領域以外の空間に放出された飛散粒子がバッファガス分子との衝突により散乱されて真空容器内に拡散したとしても、前記清浄光学面を取り囲んで設けられたダクト状の飛散粒子阻止部材により飛散粒子の前記領域内への進入を的確に阻止することができる。

【００２６】さらに、本発明にかかる飛散粒子阻止部材は、バッフルを有する（特に内側が好ましい）ダクト状の部材であることが好ましい（請求項５）。かかる構成にすると、飛散粒子阻止部材の表面面積が増大するので、飛散粒子を付着または吸着させる効果が向上する。本発明にかかる飛散粒子阻止部材は、前記ダクト内にガスを導入するためのガス導入機構が設けられ、該飛散粒子阻止部材はガス導入口を有することが好ましい（請求項６）。

【００２７】かかる構成にすると、前記光学素子または光学部材（清浄光学面）が配置されたダクト内部から真空容器内へのガス流を形成して、ダクト内に浮遊している飛散粒子をダクト外へ排除することができるので、清浄光学面への飛散粒子の付着、堆積を防止する効果がさらに増大する。かかるガスとしては、例えば、Ｋｒ、Ｈｅ、O_2 、N_2 などが使用できる。

【００２８】本発明においては、前記電極または飛散粒子阻止部材の少なくとも一部を被覆し、取り外し可能な被覆部材を設けることが好ましい（請求項７）。Ｘ線発生装置において、Ｘ線発生運転を長時間続けていると、次第に前記飛散粒子阻止部材や電極の上に飛散粒子が堆積するようになる。そこで、請求項７にかかる取り外し可能な被覆部材を設けて、この部材上に飛散粒子を堆積させる。

【００２９】そして、一定期間使用した後に、この被覆部材を取り外して新しい被覆部材と交換することにより、再び前記立体角領域内または前記励起エネルギービーム通過領域内を清浄な状態に戻すことができる。なお、被覆部材に絶縁体を用いると、この部材全体を帯電させることが可能となり、飛散粒子を収集する能力が高

まるので都合がよい。

【００３０】本発明においては、前記飛散粒子の放出量の方向分布を制御する部材であり、前記Ｘ線を取り出す方向への飛散粒子放出量を低減させる飛散粒子制御部材を設けることが好ましい（請求項８）。飛散粒子制御部材を設けると、Ｘ線の取り出し方向における飛散粒子放出量が減少するので好ましい。本発明にかかる飛散粒子制御部材に用いる材料としては、例えば、タンタル、タングステン、ダイヤモンド、セラミックなどの高融点、又は高硬度の材料が好ましい。

【００３１】これは、飛散粒子制御部材がプラズマに非常に近接した位置に配置されるので、プラズマから飛来するイオンや電子の該部材表面への衝突による該部材材料の放出を低減するためである。即ち、該部材材料の放出があると飛散粒子と同様に不都合な付着、堆積が生じるので、これを低減するのである。本発明においては、飛散粒子阻止部材を冷却する冷却機構を設けると、該部材が飛散粒子を吸着しやすくなって、阻止効果が増大するので好ましい（請求項９）。

【００３２】或いは、飛散粒子を吸着しやすいように、飛散粒子阻止部材や前記被覆部材の表面を加工（例えば、つや消し加工）することも好ましい。飛散粒子を付着、堆積させる電極または部材は、その表面積が大きい方が飛散粒子を付着、堆積させる効果（飛散粒子阻止効果）が大きいので、電極または部材の表面積を大きくすることが好ましい。

【００３３】本発明にかかるＸ線源は、励起エネルギービーム（例えば、レーザー光）を点状に集光するＸ線源（例えば、レーザープラズマＸ線源）の他に、レーザー光を線状に集光してプラズマを生成し、プラズマ中のイオンの誘導放出を利用するＸ線レーザーであっても良い。以下、本発明を実施例により更に詳細に説明するが、本発明はこれらの例に限定されるものではない。

【００３４】

【実施例１】図１は本実施例のＸ線発生装置の概略部分構成図である。集光レンズにより集光したレーザー光（励起エネルギービームの一例）１０３を窓１０２を透過させて、真空容器１０１内に配置された標的部材１０４上に集光照射することによりプラズマ１０５を生成する。

【００３５】このプラズマ１０５から発生したＸ線の一部１０７を取り出して、可視光カットＸ線透過膜（例えばＢｅ膜、Ｘ線光学素子の一例）１１１を透過させた後、他のＸ線光学素子（例えばＸ線多層膜ミラーなど）へと導く。真空容器１０１内は、ガス導入口（不図示）より飛散粒子阻止用のバッファガス（例えばＫｒガス）が導入されるとともに、真空排気装置（不図示）により排気されている。ここで、真空容器１０１内のバッファガスは、Ｘ線透過率が十分に高く、かつ、飛散粒子の速度を十分に減速できる圧力に制御されている。

【００３６】例えば、Ｋｒガスを導入して圧力を0.1 ｔｏｒｒに維持した場合、Ｋｒガス分子と数回～１０回程度の衝突により、飛散粒子はＫｒガス分子と同程度の速度でランダム方向に運動するようになる（浮遊する）。このとき、波長13.5nm近傍のＸ線の透過率は、距離１０ｃｍの位置で約８０％に達する。Ｘ線透過膜１１１は、前記標的部材１０４及び／または前記プラズマ１０５からＸ線取り出し方向以外の領域に放出された飛散粒子が付着、堆積しないように、ダクト状の飛散粒子阻止部材１０８により取り囲まれている。

【００３７】また、ダクト内空間１１２には、Ｘ線１０７を取り出す範囲に相当する立体角領域に隣接または近接させて、前記飛散粒子阻止部材１０８により阻止されなかった飛散粒子１０６をイオン化及び／または静電吸着させる電極１０９、１１０が配置されている。電極１１０は、電極１０９及び取り出しＸ線１０７（立体角領域）を取り囲む形状をしている。電極１０９にはマイナスの、電極１１０にはプラスの電圧が印加されている（電源及び配線などは不図示）。

【００３８】ダクト内空間（遮蔽空間）１１２に入り込んだ飛散粒子１０６は遮蔽空間１１２内のガス分子との衝突により減速され、遮蔽空間内を浮遊するようになる。電界印加領域に入り込んだ飛散粒子は、電界により直接イオン化され、或いはイオン化されたガス分子との衝突によりイオン化される。マイナスにイオン化された飛散粒子は、プラス電極１１０に引き寄せられ、この電極上に静電吸着されて付着、堆積する。また、プラスにイオン化された飛散粒子は、マイナス電極１０９に引き寄せられ、この電極上に静電吸着されて付着、堆積する。また、一部の飛散粒子は、阻止部材１０８上に付着、堆積する。

【００３９】この様にして、遮蔽空間１１２内に浮遊している飛散粒子は、電極１０９、１１０及び部材１０８上に収集されるので、遮蔽空間１１２内に浮遊している飛散粒子量は激減する。そのため、Ｘ線透過膜１１１上への付着、堆積量は著しく低減され、Ｘ線透過率の低下が抑えられるので、長時間にわたってＸ線発生装置を利用することができる。

【００４０】前記の例では、遮蔽空間１１２内にプラス、マイナス２つの極を配置したが、どちらか一方の極だけでも良い。例えば、電極１０９をマイナスに印加し、電極１１０を接地して真空容器１０１及び阻止部材１０８などと同電位にすると、プラスにイオン化された飛散粒子は電極１０９上に、マイナスにイオン化された飛散粒子は電極１１０上や飛散粒子阻止部材１０８の内面上にそれぞれ静電吸着されて付着、堆積する。

【００４１】飛散粒子が正負イオンのどちらにイオン化するか予め分かっているときは、電圧印加電極の極性を決めることにより、飛散粒子を電圧印加電極上か、或いは接地電極上及び阻止部材上のどちらか一方に堆積させ

ることができる。

【００４２】

【実施例２】図２は本実施例のＸ線発生装置の概略部分構成図である。実施例１に於いて、飛散粒子収集側を電極１１０及び阻止部材１０８とすると、イオン化された飛散粒子の一部は阻止部材１０８や真空容器１０１と電気的に接続されているＸ線透過膜１１１上にも僅かながら付着、堆積してしまう。

【００４３】これを防ぐために、本実施例ではＸ線透過膜２１０（Ｘ線光学素子の一例）を絶縁体２１１を介して真空容器２０１に取り付けている。即ち、Ｘ線透過膜２１０は真空容器２０１から電気的に隔離され、このＸ線透過膜２１０は、電極２０９と同電位となるように電源（不図示）に接続されている。なお、電極は一つであり、その他の構成は、実施例１と同様である。

【００４４】例えば、電極２０９をマイナスに印加し、飛散粒子はマイナスにイオン化するとすると、イオン化された飛散粒子は接地されている阻止部材２０８上に付着堆積するが、電極と同電位になっているＸ線透過膜２１０上には付着しない。この様にすることにより、イオン化された飛散粒子を阻止部材２０８内面のみに付着させることができる。

【００４５】Ｘ線透過膜２１０に印加する電圧値は必ずしも電極２０９に印加されている電圧値と同じでなくても良く、少なくとも電極と同じ極性であればよい。本実施例のＸ線発生装置によれば、Ｘ線透過膜２１０上への付着、堆積量は著しく低減され、Ｘ線透過率の低下が抑えられるので、長時間にわたってＸ線発生装置を利用することができる。

【００４６】

【実施例３】図３は本実施例のＸ線発生装置の概略部分構成図である。実施例１に於いて、飛散粒子収集側を電極１１０及び阻止部材１０８とすると、イオン化された飛散粒子の一部は阻止部材１０８や真空容器１０１と電気的に接続されているＸ線透過膜１１１上にも僅かながら付着、堆積してしまう。

【００４７】これを防ぐために、本実施例では、Ｘ線透過膜３１０（Ｘ線光学素子の１例）の前（プラズマ側）に阻止部材３０８と同電位に保持されたメッシュ電極３１１を配置し、メッシュ電極３１１側にイオン化された飛散粒子が堆積するようにしている。なお、電極は一つであり、その他の構成は実施例１と同様である。

【００４８】本実施例のＸ線発生装置によれば、Ｘ線透過膜３１０上への付着、堆積量は著しく低減され、Ｘ線透過率の低下が抑えられるので、長時間にわたってＸ線発生装置を利用することができる。

【００４９】

【実施例４】図４は本実施例のＸ線発生装置の概略部分構成図である。本実施例では、遮蔽空間内４１２へガスを導入するための導入口４１１を設けている。なお、電極は一つであり、その他の構成は、実施例１と同様である。この導入口４１１からガスを導入することにより、遮蔽空間４１２から真空容器４０１内部へのガス流が形成されて、遮蔽空間４１２内の飛散粒子は真空容器４０１内へ排出される。

【００５０】そのため、遮蔽空間４１２内の飛散粒子量は激減し、Ｘ線透過膜４１０上への付着、堆積量は著しく低減される。そして、Ｘ線透過膜４１０のＸ線透過率低下が抑えられるので、長時間にわたってＸ線発生装置を利用することができる。

【００５１】

【実施例５】図５は本実施例のＸ線発生装置の概略部分構成図である。本実施例では、遮蔽空間５１２内に電極５０９を配置し、飛散粒子阻止部材５０８の内面を取り外し可能なシート（被覆部材の一例、例えば、紙、テフロンシートなど）５１１で被覆してある。その他の構成は、実施例１と同様である。

【００５２】今、電極５０９をマイナスに印加し、阻止部材５０８及び真空容器５０１は接地されているとし、飛散粒子はマイナスにイオン化されるとする。そうすると、イオン化された飛散粒子は、阻止部材５０８側に引き寄せられてシート５１１上に付着、堆積する。長期間にわたってＸ線発生装置を運転し続けると、飛散粒子がシート５１１上に多量に堆積するが、シート５１１を交換するだけで容易に遮蔽空間５１２内から収集された飛散粒子を取り除くことができ、遮蔽空間５１２内を元の清浄な状態に戻すことができる。

【００５３】本実施例では、飛散粒子を収集する交換可能な部材としてシートを用いたが、これは任意の形状、材料でよい（絶縁体が好ましい）。本実施例のＸ線発生装置によれば、Ｘ線透過膜５１０上への付着、堆積量は著しく低減され、Ｘ線透過率の低下が抑えられるので、長時間にわたってＸ線発生装置を利用することができる。

【００５４】

【実施例６】図６は本実施例のＸ線発生装置の概略部分構成図である。実施例１～５では、飛散粒子阻止部材がＸ線光学素子を囲むように配置されていたが、必ずしもその必要はない。本実施例では、プラズマ６０５Ｘ線源と多層膜Ｘ線反射ミラー６１０（Ｘ線光学素子の一例）とは、それぞれ別の真空容器（６０１と６１１）内に配置されており、その途中に飛散粒子阻止部材６０８と電極６０９が設けられている。

【００５５】この場合も、前述と同様な効果によりイオン化された飛散粒子は、電極６０９上、阻止部材６０８上、或いは途中の真空配管内面上に付着、堆積するので、多層膜Ｘ線反射ミラー６１０上に付着、堆積する飛散粒子量を低減させることができる。本実施例のＸ線発生装置によれば、Ｘ線透過膜６１０上への付着、堆積量は著しく低減され、Ｘ線透過率の低下が抑えられるの

で、長時間にわたってX線発生装置を利用することができる。

【0056】以上の実施例1～6では、X線光学素子への飛散粒子の付着、堆積量を低減することについて述べてきたが、レーザー光導入光学素子（レーザー光導入窓や集光光学素子など）への飛散粒子の付着、堆積量を低減することも同様に可能である。即ち、励起エネルギービームであるレーザー光が通過する領域に隣接または近接させて設けられた飛散粒子阻止部材により飛散粒子の前記領域内への進入を阻止することで、該領域内に配置された清浄光学面への飛散粒子の付着、堆積を防止することができる。

【0057】さらに、励起エネルギービームであるレーザー光が通過する領域に隣接または近接させて、飛散粒子阻止部材よりも前記領域側に位置する電極であり飛散粒子をイオン化及び／または静電吸着させる電極を設けると、前記領域内に進入してきた飛散粒子を電極または飛散粒子阻止部材が静電吸着することにより、該領域内に配置された清浄光学面への飛散粒子の付着、堆積をさらに防止することができる。

【0058】

【発明の効果】以上説明したように、本発明のX線発生装置によれば、清浄光学面への飛散粒子の付着、堆積を防止する効果が著しく、その結果、長時間安定して装置を使用できる。

【図面の簡単な説明】

【図1】は、実施例1のX線発生装置の概略部分構成図である。

【図2】は、実施例2のX線発生装置の概略部分構成図である。

【図3】は、実施例3のX線発生装置の概略部分構成図である。

【図4】は、実施例4のX線発生装置の概略部分構成図である。

【図5】は、実施例5のX線発生装置の概略部分構成図である。

【図6】は、実施例6のX線発生装置の概略部分構成図である。

【符号の説明】

１０１，２０１，３０１，４０１，５０１，６０１…真空容器

１０２，２０２，３０２，４０２，５０２，６０２…レーザー光導入窓

１０３，２０３，３０３，４０３，５０３，６０３…レーザー光（励起エネルギービームの一例）

１０４，２０４，３０４，４０４，５０４，６０４…標的部材

１０５，２０５，３０５，４０５，５０５，６０５…プラズマ

１０６，２０６，３０６，４０６，５０６，６０６…飛散粒子

１０７，２０７，３０７，４０７，５０７，６０７…利用するX線

１０８，２０８，３０８，４０８，５０８，６０８…飛散粒子阻止部材

１０９，２０９，３０９，４０９，５０９，６０９…電極

１１０…電極

２１０，３１０，４１０，５１０…可視光カットX線透過膜（清浄光学面及び光学素子の一例）

６１０…多層膜X線反射ミラー（清浄光学面及び光学素子の一例）

１１１…可視光カットX線透過膜（清浄光学面及び光学素子の一例）

２１１…絶縁体

３１１…メッシュ電極

４１１…ガス導入口

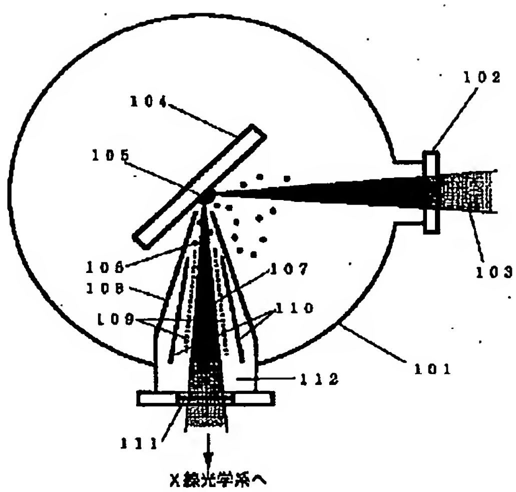
５１１…シート（取り外し可能な被覆部材の一例）

６１１…真空容器

１１２，２１２，３１２，４１２，５１２，６１２…遮蔽空間

以　上

【図1】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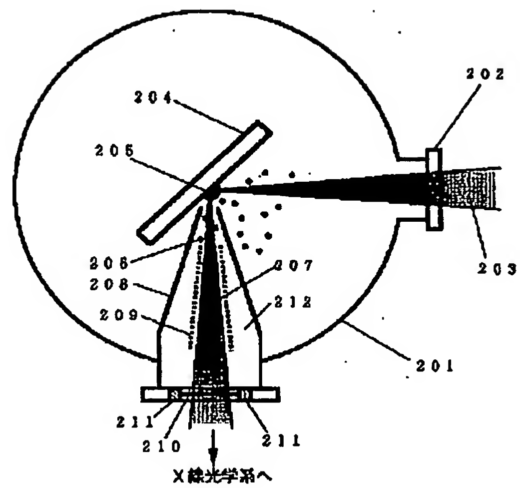
X線光学系へ

【図2】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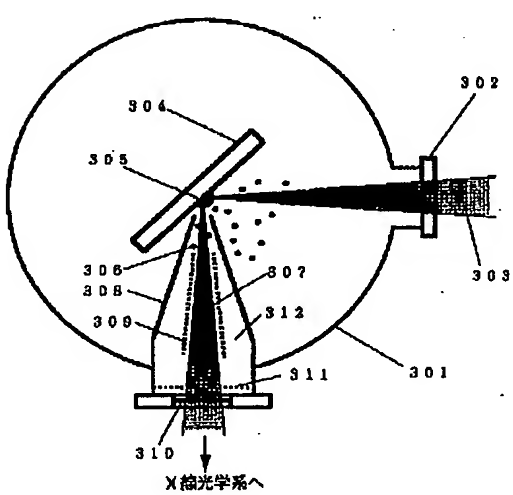
X線光学系へ

【図3】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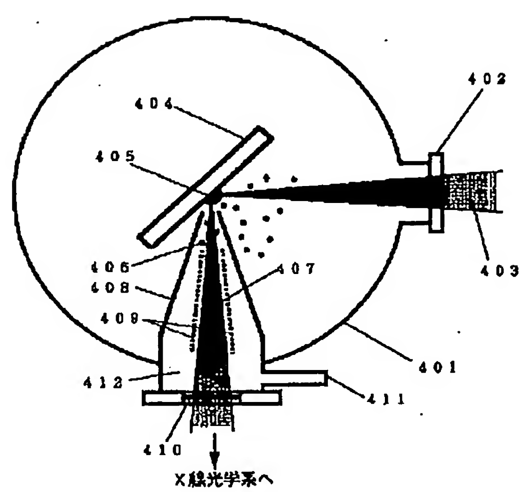
X線光学系へ

【図4】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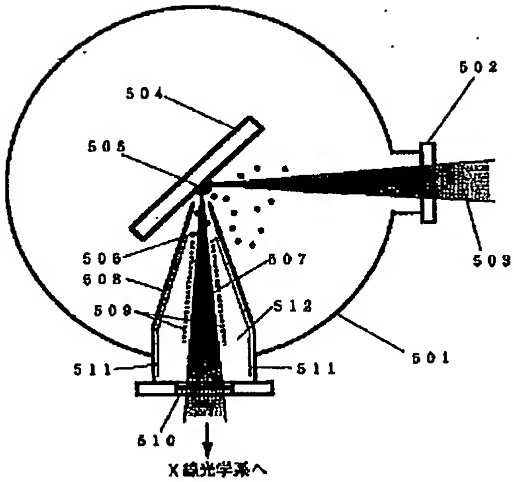
X線光学系へ

【図5】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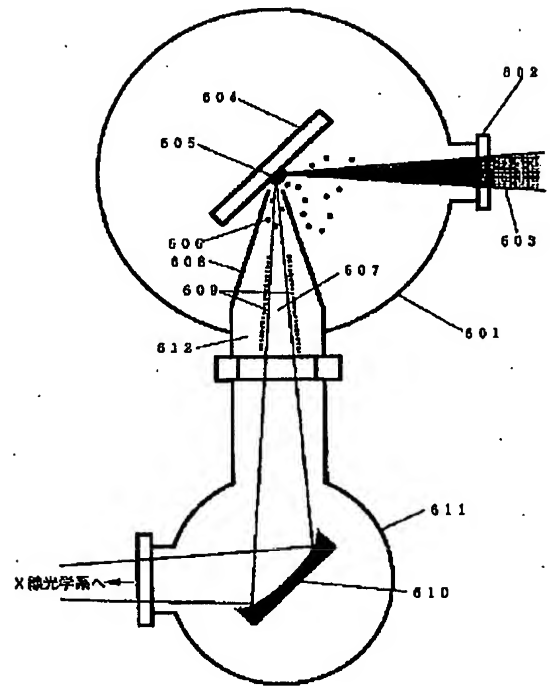
X線光学系へ

【図6】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X線光学系へ
610

【公報種別】特許法第１７条の２の規定による補正の掲載
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【発行日】平成１５年6月２０日（２００３．６．２０）

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H05G 2/00
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H05G 1/00 K
1/02 J

【手続補正書】
【提出日】平成１５年3月１３日（２００３．３．１３）
【手続補正１】
【補正対象書類名】明細書
【補正対象項目名】発明の名称
【補正方法】変更
【補正内容】
【発明の名称】Ｘ線発生装置及びＸ線露光装置
【手続補正２】
【補正対象書類名】明細書
【補正対象項目名】特許請求の範囲
【補正方法】変更
【補正内容】
【特許請求の範囲】
【請求項１】プラズマから輻射されるＸ線を用いたＸ線発生装置において、
プラズマからＸ線を取り出す範囲に相当する立体角領域に隣接または近接させて配置された飛散粒子を阻止するための飛散粒子阻止部材と、
前記飛散粒子をイオン化及び／または静電吸着させる電極とを有し、
前記電極が前記飛散粒子阻止部材よりも前記立体角領域側あるいは前記立体角領域内に配置されていることを特徴とするＸ線発生装置。
【請求項２】プラズマから輻射されるＸ線を用いたＸ線発生装置において、
前記プラズマを形成するための標的部材に照射される励起エネルギービームが通過する領域に隣接または近接させて配置された飛散粒子を阻止するための飛散粒子阻止部材と、
前記飛散粒子阻止部材よりも前記励起エネルギービーム通過側に配置され、前記飛散粒子をイオン化及び／または静電吸着させる電極とを設けたことを特徴とするＸ線発生装置。
【請求項３】　前記電極に直流電圧または交流電圧を印可することを特徴とする請求項１～２記載のＸ線発生装置。
【請求項４】　前記減圧された真空容器内に飛散粒子を阻止するためのバッファガスを導入する機構を設けたことを特徴とする請求項１～３記載のＸ線発生装置。
【請求項５】　前記飛散粒子阻止部材は、前記立体角領域または前記励起エネルギービーム通過領域に配置された光学素子または光学部材に飛散粒子が衝突、付着または堆積するのを防止するためのダクト状の部材であり、前記光学素子または光学部材を取り囲んで設けられていることを特徴とする請求項１～４記載のＸ線発生装置。
【請求項６】　前記飛散粒子阻止部材は、バッフルを有するダクト状の部材であることを特徴とする請求項５記載のＸ線発生装置。
【請求項７】　前記ダクト内にガスを導入するためのガス導入機構が設けられていることを特徴とする請求項５または６記載のＸ線発生装置。
【請求項８】　前記ダクト内に導入するガスが、クリプトン(Kr)、ヘリウム(He)、酸素(O_2)、窒素(N_2)のうち少なくとも１つを含むガスであることを特徴とする、請求項７記載のＸ線発生装置。
【請求項９】　前記電極または飛散粒子阻止部材の少なくとも一部を被覆し、取り外し可能な被覆部材を設けたことを特徴とする請求項１～８記載のＸ線発生装置。
【請求項１０】　前記被覆部材が紙、テフロンなどの絶縁体であることを特徴とした請求項９記載のＸ線発生装置。
【請求項１１】　光学素子に前記電極と同極性の電圧を印加することを特徴とする請求項１～１０記載のＸ線発生装置。
【請求項１２】Ｘ線光学素子が、前記プラズマが生成されている真空容器とは別の真空容器内に配置されており、前記プラズマと前記Ｘ線光学素子の間に飛散粒子阻

止部材及び電極が配置されていることを特徴とする請求項１～１１に記載のＸ線発生装置。
【請求項１３】前記電極の形状が線状、メッシュ状、板状であることを特徴とする、請求項１～１２記載のＸ線発生装置。
【請求項１４】光学素子と前記プラズマの間に前記飛散粒子阻止部材と同電位に保持された電極を更に配置したことを特徴とする請求項１～１２記載のＸ線発生装置。
【請求項１５】　前記飛散粒子の放出量の方向分布を制御する部材であり、前記Ｘ線を取り出す方向への飛散粒子放出量を低減させる飛散粒子制御部材を設けたことを特徴とする請求項１～１４記載のＸ線発生装置。
【請求項１６】　前記飛散粒子制御部材がタンタル(Ta)、タングステン(W)、ダイヤモンド、セラミックスのうち少なくとも１つを含む材料からできていることを特徴とする請求項１５記載のＸ線発生装置。
【請求項１７】　前記飛散粒子阻止部材を冷却する冷却機構を設けたことを特徴とする請求項１～１６記載のＸ線発生装置。
【請求項１８】請求項１から１７のいずれか１項に記載のＸ線発生装置を備えたＸ線露光装置。